# TRAVEL PATH SHAPE DISPLAY DEVICE AND MAP DATA BASE RECORDING MEDIUM


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**- european:**
**Application number:** JP19990011876 19990120
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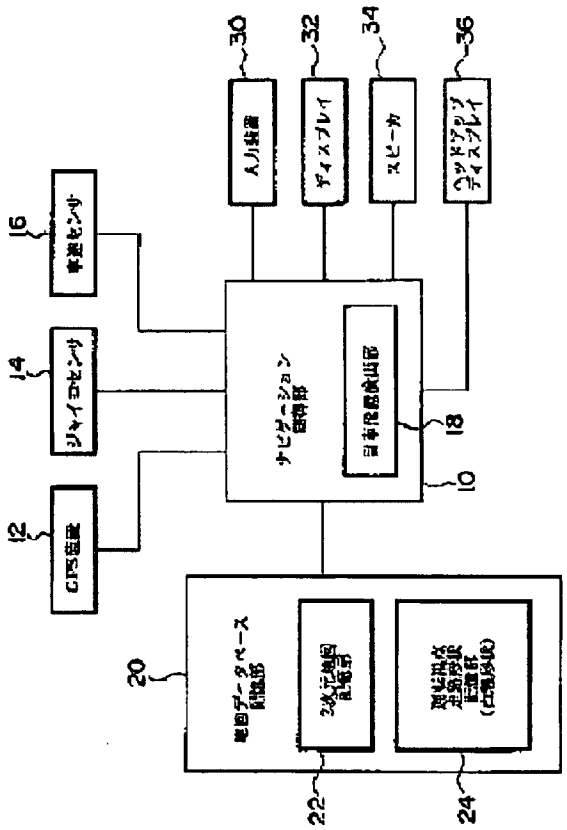
Abstract of **JP2000211452**

PROBLEM TO BE SOLVED: To surely and quickly display a travel path shape viewed from a visual point of a driver without being affected by environmental conditions. SOLUTION: A driving visual point travel path shape storing part 24 relates each of a plurality of spots on a road of a map and a driving visual point travel path shape showing the shape of a front travel path viewed from a visual point of a vehicle driver at each spot and stores the spots and shape. Preferably, the shape of the travel path is the shape of a white line drawn on the road. A self-vehicle location detecting part 18 detects a self-vehicle location. A navigation control part 10 reads the shape of the white line corresponding to the self-vehicle location from the driving visual point travel path shape storing part 24 and displays the shape of the white line on a head up display 36. Preferably, sideway dislocation of the vehicle from the travel path, the direction of a vehicle line and inclination of the direction of the vehicle are detected, the shape of the white line is corrected and the shape of the white line is displayed.

15

【図７】　車線方向に対する車両方向の傾きに関して白線形状を補正する処理を示す図である。

【図８】　車線方向に対する車両方向の傾きに関して白線形状を補正する処理を示す図である。

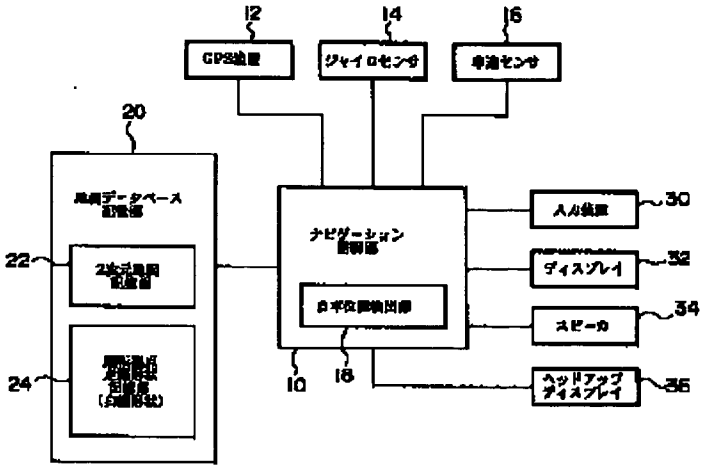
【図９】　車種別の視点高さに適合した白線データ生成処理を示す図である。

【符号の説明】

16

１０　ナビゲーション制御部、１２　ＧＰＳ装置、１４　ジャイロセンサ、１６　車速センサ、１８　位置検出部、２０　地図データベース記憶部、２２　２次元地図記憶部、２４　運転視点走路形状記憶部、３０　入力装置、３２　ディスプレイ、３４　スピーカ、３６　ヘッドアップディスプレイ。

【図１】

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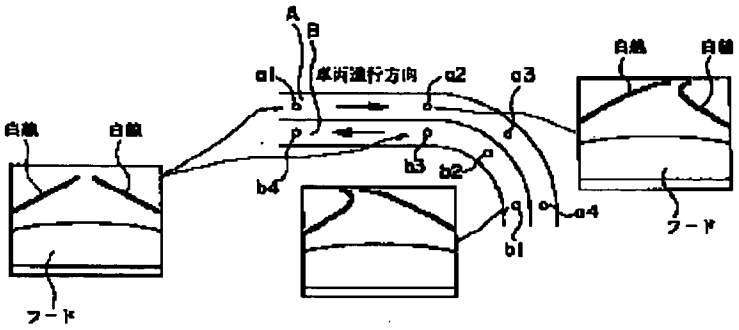


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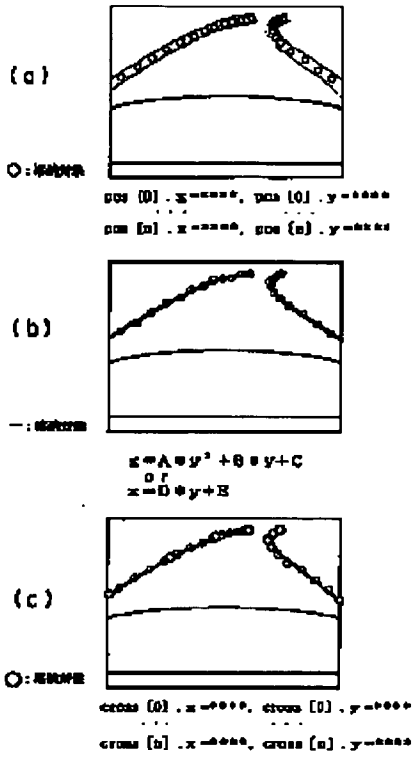


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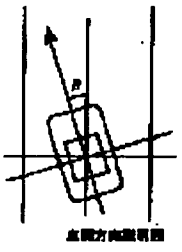


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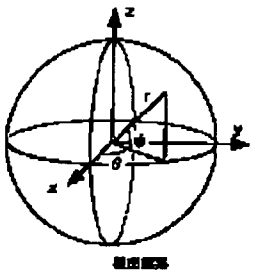


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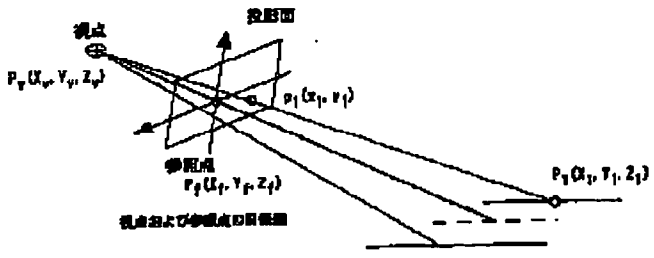

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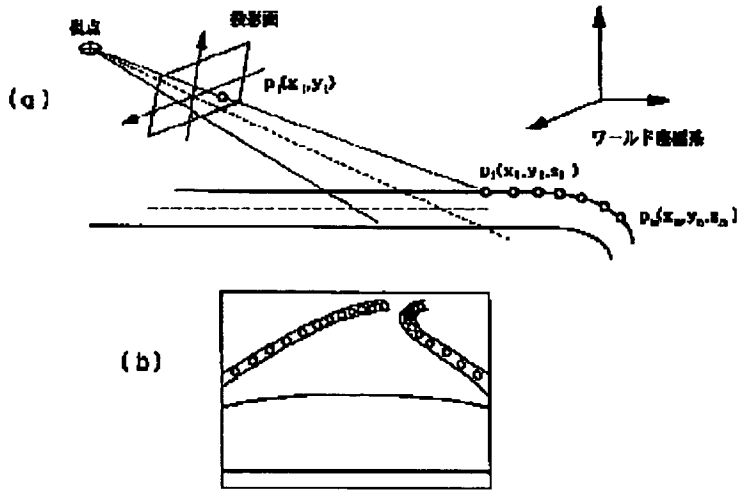
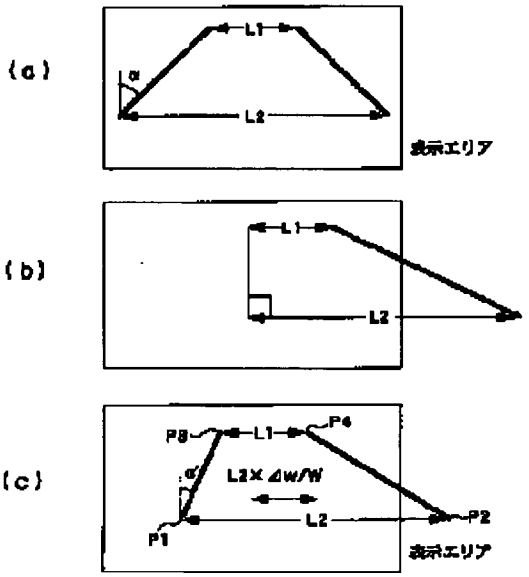

(a)
視点
投影面
ワールド座標系
(b)

【図５】


(a)
L1
L2
表示エリア
(b)
L1
L2
(c)
P3
L1
P4
L2×⊿w/W
L2
P2
P1
表示エリア

【図９】


高精度地図
D／B
パラメータ○
パラメータ△
○○○用
D／B
△△△用
D／B

* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the medium which recorded the map data base suitable for using for the above-mentioned display device, concerning the roadway form display device which can display certainly and promptly the form of a roadway where this invention was seen from a driver's viewpoint.
[0002]
[Description of the Prior Art]When operating vehicles, a driver grasps the roadway form ahead of vehicles by viewing through a windshield. However, it may be hard to grasp front roadway form under the influence of the curve of weather conditions and a roadway, peripheral vehicles, a building, etc. Then, it is preferred to equip vehicles with the equipment which grasps the roadway form of the front seen from a driver's viewpoint, and to show a driver roadway form.
[0003]JP,H7-57200,A has disclosed the equipment which detects a white line on the street from the road picture photoed with the in-vehicle camera, and displays the detected white line. The driver can grasp front roadway form, seeing the white line displayed on the display device.
[0004]
[Problem to be solved by the invention]However, camera photographing cannot display roadway form under difficult environment (for example, the inside of fog). A white line may be undetectable from a taken image like a snowy road. A white line cannot be photoed when a large sized vehicle is furthermore ahead. Thus, the environmental condition as which the roadway form display device using a camera functions effectively is restricted.
[0005]In spite of having actually desired a display of roadway form strongly just under environment with difficult grasp of roadway form visually for a driver, under such environment, detection of roadway form was difficult and it was difficult to play a role which assists a driver.
[0006]In a well-known navigation device, a two-dimensional map which looked at a vehicle circumference from right above the sky is displayed. However, road geometry seen from right above

differs from roadway form where the front was seen from a driver's viewpoint, greatly. Even if it sees such a superficial map, it is not easy for a driver to grasp front roadway form intuitively.

[0007]Navigation devices which display a map in three dimensions, such as what is called a bird view, are well-known. It is displayed after a two-dimensional map which looked at the self-vehicle position circumference from right above is processed into a map seen from the slanting upper part. However, in this kind of equipment, a screen scrolling becomes quite late compared with the usual map display. In order that this may perform coordinate conversion, such as projection conversion, to many points, it is considered to be the causes that there are many amounts of data processing and that display object data for a slanting display increases.

[0008]Although lane (lane) guidance on a three dimentional display generally is not performed under the present circumstances, when trying to perform lane guidance, it is required that it should combine with movement of vehicles and a display should be updated at high speed. A calculation load is large and it is not easy to meet such a demand in processing with much handling data volume, either.

[0009]This invention is made in light of the above-mentioned problems, and the purpose is to enable presentation of roadway form seen from a driver's viewpoint certainly and promptly, without receiving influence in an environmental condition.

[0010]

[Means for solving problem]In order to attain the above-mentioned purpose, a roadway form display device of this invention, A roadway shape memory means to associate and memorize operation viewpoint roadway form of expressing roadway form of the front seen from a vehicle operator's viewpoint, at two or more each and every place points of a point on a road of a map, A self-vehicle position detecting means which detects a self-vehicle position, a displaying means which displays said operation viewpoint roadway form, and a display processing means which reads operation viewpoint roadway form corresponding to a self-vehicle position which said self-vehicle position detecting means detected from said roadway shape memory means, and is displayed on said displaying means are included.

[0011]According to this invention, operation viewpoint roadway form corresponding to a self-vehicle position is read from memory storage, and is displayed. Roadway form can be displayed also under environment where a driver's visibility falls.

[0012]According to this invention, operation viewpoint roadway form of an applicable point is related with point data of a map. Namely, operation viewpoint roadway form is beforehand prepared for every every place point. Therefore, much point data is read, a lot of ********** data processing is unnecessary in a conversion process in the case of a display of roadway form, and roadway form of an operation viewpoint can be promptly displayed on it.

[0013]Preferably, said roadway shape memory means has memorized a discrete representative point set extracted from roadway form when the front was seen from a driver's viewpoint in an applicable position as said operation viewpoint roadway form of each position. Said display processing means contains a means to generate continuous roadway form, based on said discrete representative point

set. According to this mode, data volume which a roadway shape memory means should memorize is reducible. Since operation viewpoint roadway formed data was prepared for every every place point data, data volume can avoid generating of the ********** situation enormously.
[0014]Said display processing means chooses preferably operation viewpoint roadway form read from said memory measure based on a roadway or an advance schedule roadway of the self-vehicle position circumference. Efficient processing can be performed by choosing a high roadway of a possibility of actually running.
[0015]A strike slip detection means to detect a strike slip of vehicles to a roadway is included preferably. In said display processing means, coordinate conversion of the operation viewpoint roadway form corresponding to a self-vehicle position read from said roadway shape memory means is carried out to roadway form seen from a viewpoint which carried out the strike slip based on said strike slip. Roadway form which agreed in a actual situation by this can be shown to a driver. That is, vehicles do not necessarily run a regular position in a roadway, a running position shifts to a transverse direction, and a position of a viewpoint also shifts in connection with it. According to this invention, even if a viewpoint corresponding to roadway form memorized and a actual viewpoint shift, roadway form seen from a actual viewpoint can be displayed.
[0016]The inclination detecting means which detects the inclination of the direction of vehicles to the direction of a roadway is included preferably. In said display processing means, coordinate conversion of the operation viewpoint roadway form corresponding to the self-vehicle position read from said roadway shape memory means is carried out to the roadway form seen from the leaning viewpoint based on said inclination. This mode also makes it possible to show a driver the roadway form corresponding to a actual situation. That is, according to this invention, although the direction of movement of vehicles is not necessarily in agreement with the direction of a roadway, even if the direction of vehicles currently assumed in the roadway form memorized and the actual direction of vehicles shift, the roadway form of the vehicle front in accordance with a actual situation can be displayed.
[0017]Said displaying means is a HUD which displays a picture on the windshield of vehicles preferably. Since the feeling for a driver when the display of roadway form is seen agrees with actual drive feeling, the support effect to a driver increases.
[0018]Said operation viewpoint roadway form is data in which the form of a line of expressing the lane with which it was underlined on the roadway is shown preferably. A lane display line (typically white line) is a suitable index showing roadway form. Since an updating display can be performed at high speed by applying this invention to lane guidance, a driver can be provided with intelligible guidance.
[0019]Another mode of this invention is the map data recording medium with which the map data base of the road was recorded. The operation viewpoint roadway form of expressing with a map data base the roadway form of the front seen from a vehicle operator's viewpoint at two or more each and every place points of the point on a road is associated.
[0020]

[Mode for carrying out the invention]Hereafter, the suitable embodiment (henceforth an embodiment) of this invention is described with reference to Drawings. According to this embodiment, an in-vehicle navigation device is equipped with the roadway form display device of this invention in one.
[0021]Drawing 1 is a block diagram showing the composition of the navigation device of this embodiment. The navigation control section 10 is controlling the whole equipment, and performs navigation related processing of path computation, course guidance, etc. The control section 10 functions also as a display processing means of this invention.
[0022]The navigation control section 10 is connected with the GPS (global positioning system) equipment 12, the gyro sensor 14, and the speed sensor 16. Based on the input signal from these sensors, the self-vehicle position detector 18 of the control section 10 searches for the position of vehicles. GPS device 12 searches for a self-vehicle position as everyone knows from the electric wave sent from an artificial satellite. A self-vehicle position is caught using the direction of movement and speed which the gyro sensor 14 and the speed sensor 16 detect. It is also preferred to perform map matching using the map data memorized by the map data base storage parts store 20.
[0023]The navigation control section 10 performs navigation processing using the self-vehicle position which the position detector 18 detected. If a user inputs a running purpose place using the input device 30, the control section 10 will search for and set up the course from a self-vehicle position to the destination. Path computation is performed by processing of a Dijkstra method etc. using the map data stored in the two-dimensional map storage parts store 22 of the map data base storage parts store 20. The map of the self-vehicle position circumference is read from the two-dimensional map storage parts store 22, and is displayed on the display 32 as a displaying means. A setting-out course is displayed in distinction from other roads. The audio assist which tells the course in a crossing, etc. is suitably outputted from the loudspeaker 34.
[0024]As a feature of a "display of roadway form" book embodiment, the map data base storage parts store 20 has the operation viewpoint roadway shape memory part 24, and this storage parts store 24 is one mode of the roadway shape memory means of this invention. The every place point on a road is related with the operation viewpoint roadway form of this invention of expressing the roadway form of the front seen from a driver's viewpoint at the applicable point, in the storage parts store 24.
[0025]With reference to drawing 2, the memory information on the operation viewpoint roadway shape memory part 24 is explained concretely. Two or more points a1-a4, b1 - b4 are set to the lanes A and B on a road which counter. The storage parts store 24 has memorized the roadway-shaped data seen from a driver's viewpoint on each point. According to this embodiment, the white line form drawn on the road is used as roadway configuration information. The driver can grasp roadway form easily from the display of a white line. If white line form is applied, the amount of stored data and the amount of processed data can be stopped few. White line form is adopted as roadway form from such a viewpoint.
[0026]In drawing 2, a front road is a straight line the point a1 on the 1st lane A. Therefore, the white line form showing a straight line is related with the point a1. In the point a2, since the front road is the

right curve, the white line form of the right curve is related with the point a2. On the other hand, the point b1 on the 1st lane A and the 2nd lane B that counters, since the front road is the left curve, the white line form of the left curve is related with the point b1. The point b3 is related with linear white line form.

[0027]Although the point a2 and the point b3 are the places same on a road, they belong to the lane of a counter direction. Therefore, the front roadway form of both the points a2 and the point b3 differs, and the white line form memorized also differs. Thus, different white line form according to direction of a lane is memorized.

[0028]It is beforehand created by projection conversion and white line formed data is memorized by it, as shown in drawing 3. The viewpoint of the driver of the standard physique in case standard vehicles are in the center of a lane is set up. Many points P1-Pn are set up on the white line of the road ahead of a viewpoint. The point p1 (x1, y1) which projected the one point P1 (X1, Y1, Z1) on the surface of projection on the basis of the viewpoint is searched for. By the same coordinate conversion, the point which should be displayed on a surface of projection is searched for from other points on a white line. Thus, the front white line form which is shown in drawing 3 (b) and which was seen from the viewpoint is generated.

[0029]It returns to drawing 1, and if a driver operates the input device 30 and directs a display of roadway form, the navigation control section 10 will perform display processing of operation viewpoint roadway form. First, a self-vehicle position is searched for. And white line form which relates with a position searched for and is memorized beforehand is read from the operation viewpoint roadway shape memory part 24. At this time, as explained using drawing 2, white line form corresponding to a direction of movement of vehicles is read. Read white line form is displayed on HUD 36 under control of the navigation control section 10. HUD 36 is equipment which projects an image on a windshield of vehicles as everyone knows.

[0030]As explained above, according to this invention, roadway form can be certainly displayed also by an environmental condition with a driver's low visibility. For example, in the weathers, such as fog, it is hard to grasp roadway form depending on viewing. When a road is covered in snow, or when a large-size car is ahead, it is hard to grasp roadway form similarly. Even if it photos front scenery with a camera in such a situation, grasp of a taken image to roadway form is difficult. However, since roadway form is displayed using a detection self-vehicle position and memory information according to this invention, roadway form can be certainly displayed also by the above-mentioned environmental condition.

[0031]In this embodiment, white line formed data to an every place point is generated beforehand, and is prepared. Here, it is assumed that white line form was not prepared beforehand. In this case, generation processing of white line form where it explained using drawing 3 must be performed in real time. It not only reads data of a self-vehicle position from memory storage, but prediction of data in which a point on a front white line is shown from a self-vehicle position is performed further. Coordinate conversion of the predicted data is carried out on the basis of the viewpoint starting point,

projection conversion is carried out to a surface of projection, and an acquired picture is displayed. A lot of data processing is needed, and a quick and suitable renewal of a display becomes difficult.
[0032]On the other hand, according to this invention, prediction of data is unnecessary and only data relevant to a its present location point should be read from memory storage. It is because white line form seen from a driver's viewpoint is already prepared as some point data. Predicted coordinate transformation processing of a data constellation is also unnecessary. Therefore, white line form can be displayed promptly. Also when a quick display of a white line performs guidance of a rain change, etc., it is preferred.
[0033]The navigation control section 10 chooses preferably the white line form read from the operation viewpoint roadway shape memory part 24 based on the roadway or advance schedule roadway of the self-vehicle position circumference. An advance schedule roadway is appointed from the setting-out course used for course guidance. Efficient processing can be performed by narrowing down the data read from memory storage based on the high roadway of a actual possibility of running.
[0034]In this embodiment, white line form is displayed on HUD 36 as mentioned above. Therefore, since the feeling for a driver when the display of roadway form is seen agrees with actual drive feeling, the bigger driving support effect is acquired. Of course, white line form may be displayed also on the display 32. In addition to white line form, the sign around the road on other information, for example, a road, etc. may be displayed.
[0035]Although total lane form may be displayed, it is also preferred to display the lane form which a self-vehicle is running on the road which has two or more lanes in "processing about road of two or more lanes" one way. In recent years, the highly precise detecting position technology called RTK (Realtime Kinematic)-GPS is proposed. The lane under run is distinguished using such a technique. The white line form according to lane is memorized in the operation viewpoint roadway shape memory part 24, and applicable data is displayed on it.
[0036]A definition of a self-lane cannot be performed on a road without a "processing about road without center line" center line. Then, white line form when both directions are seen is memorized about an every place point on a road. And white line form corresponding to a direction of movement is read and displayed.
[0037]White line form shown in "operation viewpoint white line-shaped data volume reduction" drawing 3 is a set of a point on a surface of projection. If data of a coordinate conversion result of drawing 3 is simply stored for every point, the amount of stored data will become huge. Then, it is preferred to reduce data volume which the operation viewpoint roadway shape memory part 24 should memorize, as it is shown in the following (1) - (3).
[0038](1) From a set of many points which data is thinned out and show storing white line form, data is operated on a curtailed schedule suitably and data reduction can be performed by leaving a representative point. If drawing 4 (a) is referred to, even if a point is set up at equal intervals on a actual road, on a surface of projection, an interval of a point will become narrow, so that it goes far

away. Then, an interval of a thinning and a representative point is made large for many points, so that it goes in the distance. For example, it is suitable for every every every other 12four and order exponentially to make an interval of a representative point large. If such processing is performed, an appearance top for a driver can reduce data volume effectively, maintaining actually near white line form. In the case of a white line display, the navigation control section 10 reads a set of a representative point, connects suitably, and it obtains continuous white line form.

[0039](2) It asks for an approximated curve from a calculation result, and in the parameter, when storing drawing 4 (b) is referred to, white line form on a surface of projection is approximated to a secondary curve or a straight line, for example. And a parameter of a secondary curve or a straight line is stored. Data volume can be reduced also by such processing, without spoiling white line form on a driver's appearance. In the case of display processing, the navigation control section 10 reads the above-mentioned parameter as roadway configuration information, and generates image data according to a parameter.

[0040](3) Approximate white line form to some straight lines, and as shown in storing drawing 4 (c), approximate white line form for coordinates of a corner point and an intersection to two or more straight lines. It is preferred to transpose many points to one straight line from the same viewpoint as (1), so that it goes in the distance. Coordinates of the forefront, a corner point of a straight line at the tail end, and an intersection of straight lines are stored as white line form. A form of data becomes the same representative point set as (1) fundamentally. In the case of display processing, a representative point set is read and it is tied in a straight line.

[0041]It is one form of the mode of this invention which memorizes above the discrete representative point set with which (1) and (3) were extracted from roadway form. The navigation control section 10 generates the roadway form which continues based on a representative point set.

[0042]"Amendment of white line form" operation viewpoint roadway shape memory part 24 has memorized the white line form which becomes a standard. This nominal contour is white line form when vehicles are in the center of the slow lane and the direction of a lane and the direction of vehicles (direction of movement) are in agreement. However, in the other situation, it becomes what differed in the white line form seen from a driver's viewpoint. Then, if white line form is amended according to the position and direction of vehicles as follows, the form and the image of a actual white line can be made to agree, and a driver can be provided with more convenient information. Here, white line form shall be constituted by the above-mentioned representative point data aggregate.

[0043]"amendment to the strike slip (offset) of vehicles" -- a white line form compensation process when vehicles are running the position [ center / of a lane ] horizontally shifted first is explained. In order to explain simply, a road is linear shape and the direction of vehicles assumes the case of being in agreement with a lane direction (parallel).

[0044]Drawing 5 (a) is the white line form of the standard stored in the operation viewpoint roadway shape memory part 24, i.e., the white line form which is visible from the center of a lane. On a surface of projection, the interval of two white lines is L1 in the L2 and distant place side at a near side. If a x

axis is set as the transverse direction on a screen and the y-axis is set as a lengthwise direction, the white line leans only the angle alpha to the y-axis.

[0045]Drawing 5 (b) is white line form which is visible when vehicles presuppose that it was in a position over a left-hand side white line temporarily. An interval of a transverse direction of a white line is taken equally to drawing 5 (a). The direction of a left-hand side white line is in agreement with the direction of vehicles (= the y-axis).

[0046]Drawing 5 (c) is white line form which is visible from a driver's seat in a general situation. A actual offset amount from W and a road center is set to deltaw for the actual width of street. When vehicles have offset only deltaw, suppose that an angle of inclination of the left white line is alpha' on a surface of projection. It asks for angle alpha' by a lower type (A-1) using angle-of-inclination alpha (drawing 5 (a)) of a white line of criterion data.

[0047]

[Mathematical formula 1]

alpha' = alpha x (1-deltaw/(W/2)) ... (A-1)

By using this formula, an indicative data in various offset valve positions can be created from a standard indicative data by easy calculation.

[0048]An example of a method of searching for coordinates of the both-ends points p1-p4 of two white lines of drawing 5 (c) is actually shown below. Coordinates before and behind amendment of the point p1 are set to each (x1, y1), and (x1a, y1) (the same may be said of the points p2-p3). Since it is aimed at a strike slip, amendment of a y-coordinate is unnecessary.

[0049]"Step 1" image center is searched for. Amount of gaps deltaL of a center is called for by a lower formula (A-2).

[0050]

[Mathematical formula 2]deltaL=L2*deltaw/W ... (A-2)

It asks for "Step 2" point p1 and a display position of p2 (near-side corner point of both white lines). An x-coordinate (x1a) of the point p1 after correction is called for by a lower type (A-3) from a standard x-coordinate (x1) of the point p1 memorized. An after-correction x-coordinate (x2a) of the point p2 is called for similarly.

[0051]

[Mathematical formula 3](x1a) =(x1)-deltaL ... (A-3)

"Step 3" It asks for alpha' using an above-mentioned formula (A-1). And it asks for the x-coordinate (x3a) of p3 after correction from alpha'.

[0052]

[Mathematical formula 4]

(x3a) It asks for the x-coordinate (x4a) of the point p4 which separated only L1 from the point p3 searched for at the =(x1a)+sin(alpha') * (y1-y3) ... (A-4) "Step 4" step 3 in the transverse direction.

[0053]

[Mathematical formula 5]x4a=x3a+L1 ... (A-5) Since it is aimed at offset as stated first, amendment of

a y-coordinate is unnecessary. By the above, since the coordinates of the points p1-p4 were searched for, the straight line which connects p1 and p3, and the straight line which connects p2 and p4 are drawn. The generated picture becomes the white line form where amendment to offset of vehicles was performed.

[0054]What is necessary is to have taken up and explained the straight-line road, in order to explain simply, but for what is necessary to be just to perform coordinate transformation processing in a similar manner fundamentally, even when the road curves, to consider that the lane near the vehicles is a straight line, and just to ask for angle-of-inclination alpha of a white line.

[0055]In this embodiment, it is preferred for the amount of strike slips to the center of a lane to detect using high precision positioning technology, such as above-mentioned RTK-GPS. It may have a camera which photos the white line at feet of vehicles, etc., and a strike slip may be detected from the taken image of a camera. If it is a picture underfoot, a photograph can be taken also under bad weather conditions, such as fog.

[0056]In this embodiment, although a vehicle position of a reference image is a center of a lane, other positions may be standards.

[0057]"amendment according to inclination of the direction of vehicles" -- here explains a white line form compensation process when the direction of vehicles inclines to the direction of a lane. In order to explain simply, vehicles are in the center of a lane and the amount of strike slips presupposes that it is zero. In this position, only direction of vehicles assumes that only a direction and the angle beta of a lane have shifted.

[0058]A music coordinate system as shown in drawing 6 is considered. And a surface of projection as shown in drawing 7 is assumed. By general coordinate conversion (projection conversion), when a viewpoint is expressed with a music coordinate system with a reference point, it is as follows. A reference point (point of regard) is a point of a standard on a surface of projection, for example, is a point of middle of the screen. Here, (Xv, Yv, Zv), and a reference point are set to (Xf, Yf, Zf) for a viewpoint.

[0059]

[Mathematical formula 6]

Xv=r*cos theta*cos phi+Xf -- - (B-1)

Yv=r*sin theta*cos phi+Yf -- - (B-2)

Zv=r*sinphi+Zf --- (B-3)

If the point P1 (X1, Y1, Z1) on a white line is seen from a viewpoint, the point P1 will be projected on the point p1 (x1, y1) on a surface of projection. Here, Z of a lower type is the distance of a viewpoint and a reference point.

[0060]

[Mathematical formula 7]

x1(theta)=(-(X1-Xf) *sintheta+(Y1-Yf) *costheta) *r/(r-Z) : (B-4)

y1(theta)=(-(X1-Xf) *cos theta*sin phi-(Y1-Yf) *sin theta*sin phi+(Z1-Zf) *cosphi) *r/(r-Z) : (B-5)

If it places with A=-(X1-Xf) *r/(r-Z) and B=(Y1-Yf) *r/(r-Z), a formula (B-4) will be rewritten as follows.
[0061]
[Mathematical formula 8]
x1(theta)= A*sintheta+B*costheta ... (B-6)
As shown in drawing 8, direction of vehicles considers the case where only the angle beta leans to direction of a lane. The x-coordinate of the point p1 in this case is called for by transposing theta ingredient of the music coordinates of a formula (B-6) to theta+beta. That is, the x-coordinate of the point p1 corresponding to the angle beta can be found by a lower type (B-7).
[0062]
[Mathematical formula 9]
x1(theta+beta)= A*sin(theta+beta)+B*cos (theta+beta) ... (B-7)
On the other hand, y ingredient of the point p1 is considered as follows. Since that a high-speed renewal of a display is needed is a case where it is running at a certain amount of high speed, it is thought that a range which beta can take is comparatively narrow. It is thought that the ascending vertical angle phi from the horizon is a comparatively small value. It is as follows, when theta of the above-mentioned formula (B-5) is transposed to theta+beta and further formula modification is performed under this premise.
[0063]
[Mathematical formula 10]
y1(theta+beta)=(-(X1-Xf) *sinphi* (costheta*cosbeta-sintheta*sinbeta) -(Y1-Yf) *sinphi* (sintheta*cosbeta+costheta*sinbeta)+(Z1-Zf) *cosphi) *r/(r-Z) ... (B-8)
Here, since both sinphi and sinbeta are small, further if [ consider it as sin phi*sin beta**0, and ] cosbeta**1, a result of a lower type (B-9) will be obtained after all.
[0064]
[Mathematical formula 11]
y1(theta+beta)**y1 (theta) -- - (B-9)
Even when the direction of movement of vehicles has shifted from the direction of a lane, correction of the y-coordinate of the point on a white line is more unnecessary than a formula (B-9). Even if it uses the y-coordinate of criterion data as it is, the form of the displayed white line and a actual white line is approximated, and looks the same for a driver.
[0065]In order to perform the above processing smoothly, the point data (A, B, y) which constitutes a white line is stored in the operation viewpoint roadway shape memory part 24. That is, the point of 1 is related with a set of the point data (A, B, y) on the white line which is visible from there. A and B are the coefficients of a formula (B-7), and y is y axis coordinates on a surface of projection.
[0066]In the navigation control section 10, angle-of-inclination beta of the direction of vehicles is called for from the detecting signal of a gyro sensor. Two-dimensional map data is referred to at this time. x (theta+beta) is called for by applying the coefficient A remembered to be angle-of-inclination beta and B to a formula (B-7). A y-coordinate is used without correction as it is irrespective of the size

of inclination. After asking for all the drawing points (x (theta+beta), y), the white line picture after amendment is acquired by connecting a drawing point.

[0067]"amendment of both a strike slip and inclination" -- both the strike slip of vehicles to a lane and inclination of the direction of vehicles occur simultaneously during a actual run. Therefore, it is preferred to perform two processings, strike slip amendment and inclination correction, both. Specifically, white line form when vehicles have turned to the lane direction in the center of a lane is first read as criterion data. And amendment to inclination of the direction of vehicles is performed, and amendment to a strike slip is performed. The white line form which agreed in the actual situation by this is obtained.

[0068]A compensation process of white line form was explained above. Here, although a case of a straight-line road was mainly taken up and explained, even when a road and a white line curve, coordinate conversion can amend white line form. Namely, what is necessary is just to perform processing which changes a position and a direction of a viewpoint based on a strike slip detection value and a detected inclination value.

[0069]According to this embodiment, when vehicles are in every lateral position to a lane, roadway form corresponding to a actual situation can be shown to a driver. That is, vehicles do not necessarily run a regular position in a roadway, a running position shifts to a transverse direction, and a position of a viewpoint also shifts in connection with it. However, even if a viewpoint corresponding to roadway form memorized and a actual viewpoint shift, roadway form seen from a actual viewpoint can be displayed by the above-mentioned conversion process.

[0070]According to this embodiment, even when the direction of vehicles and the direction of a lane have accomplished what kind of angle, roadway form corresponding to a actual situation can be shown to a driver. That is, a direction of movement which does not restrict but is assumed that a direction of movement of vehicles is in agreement with the direction of a roadway in roadway form memorized, and a actual direction of movement may shift. Even in such a case, roadway form of a vehicle front in accordance with a actual situation can be displayed by the above-mentioned compensation process.

[0071]And still more suitable roadway form can be displayed by performing both amendments of a strike slip and inclination.

[0072]The above-mentioned compensation process has contributed also to reduction of data volume in that white line form also with appropriate not preparing the white line formed data of other types, either can be shown about the same point.

[0073]In addition, in this embodiment, in order to amend the direction of vehicles, drawing point data (A, B, y) is memorized, but if only amendment of a strike slip is performed, drawing point data (x, y) should just only be memorized.

[0074]As explained beyond "the white line display according to type of a car", in this embodiment, the white line form which was related with the every place point on a road, and was seen from a driver's viewpoint is memorized beforehand. It is preferred for the processing which memorizes this white line

form beforehand to carry out as follows, for example.

[0075]The data (source data) of white line form when a road is seen from right above is prepared. Source data is data which becomes a raw material of the coordinate transformation processing of above-mentioned drawing 3, and is stored in the map data base storage parts store 20 of drawing 1. Source data is read by the navigation control section 10. The navigation control section 10 sets up a viewpoint and a reference point, performs coordinate transformation processing of drawing 3, and asks for the white line form seen from the desired viewpoint. As mentioned above, white line form is called for for every every place point on a map. The called-for white line formed data is stored in memory storage, and constitutes the operation viewpoint roadway shape memory part 24 of drawing 1. The memory storage of a hard disk etc. which can be written is formed as a part or all of the map data base storage parts store 20 so that white line form can be stored. The navigation control section 10 reads and processes white line form from a hard disk etc., when displaying roadway form on a display.

[0076]By the way, the form of the white line which is actually visible changes greatly with types of a car. It is because a position, an ascending vertical angle, etc. of an angle and a viewpoint which are visible change greatly with types of a car. For example, the viewpoint of the vehicles of a RV system is more nearly substantially [ than that of a sports car ] high. Then, the white line which it is preferred changing white line form according to a type of a car, and it displays by this, and the white line which is actually visible can be made to agree.

[0077]If drawing 9 is referred to, a high precision map data base holds the source data in which the white line form seen from right above is shown. The navigation control section 10 obtains the information about the height of a driver's viewpoint from the exterior. For example, the information on a type of a car, car height information, or the information on the height of a viewpoint itself is inputted. This information may be inputted from instrument mounting etc. and may be inputted by the user using an input device. A user may enable it to choose favorite viewpoint height. Based on input, the white line form corresponding to the viewpoint height and the suitable surface of projection of the vehicles is built. Thereby, the map data base according to a type of a car is built.

[0078]The modification of the above-mentioned processing is explained. The high precision map data base of drawing 9 may be the white line form (every every place point) seen from the height of the viewpoint of a standard. That is, one white line form data base on the basis of a suitable viewpoint is prepared beforehand. Based on the information on viewpoint height that it was inputted, the white line formed data of a standard is changed by the navigation control section 10, and the white line form corresponding to the viewpoint height (and reference point) of a corresponding vehicle is generated. What is necessary is just to perform coordinate transformation processing for changing the height of a viewpoint from standard viewpoint height to the viewpoint height of a corresponding vehicle.

[0079]It is thought preferred to perform processing which generates beforehand the white line form seen from "generating timing of white line formed data" operation viewpoint, and is memorized to three ones of the following timing.

[0080](1) Set the parameter (specification of a viewpoint and a reference point) for every vehicles, batch convert all the data, and store the data after conversion. There is an advantage that data peculiar to a type of a car can be used always immediately in this mode.
[0081](2) When the path computation to the destination is performed, the white line formed data of the point on a course is changed. Since it may deviate from a course and vehicles may go to another way, it is preferred to finish the conversion process of white line form also not only about a path guide but about other peripheral paths in a branch spot. For example, the white line formed data of the three directions of the crossing to which it comes for the next is amended so that a type of a car may be suited a priori.
[0082](3) The operation viewpoint white line form corresponding to the point data of the self-vehicle position circumference always performs the conversion process for type-of-a-car conformity. Front translation data is thrown away and the conversion process of the white line form of a point of approaching newly is performed as vehicles move. According to this mode, even when it is not course guidance Naka, white line form can be displayed promptly efficiently.
[0083]Adoption of above (2) may restrict that roadway form can be shown at the time of course guidance. In (3), the load of the computation of the control section 10 becomes high. Therefore, it is considered to be the most suitable to process (1).
[0084]"Map-database-recording-medium" this invention may be applied to modes other than the above-mentioned roadway form display device. For example, this invention may be realized in the mode of the recording medium which recorded the map data base. The map data explained in relation to the operation viewpoint roadway shape memory part 24 of drawing 1 is recorded on a recording medium. What can write data by arbitrary methods, such as magnetism, electrical and electric equipment, and light, may be sufficient as a recording medium, for example, CD-ROM and DVD are suitable for it. The map data base may be stored in the recording medium with other navigation related programs. Furthermore, this invention may be applied to other modes, for example, the mode of a method.
[0085]
[Effect of the Invention]As explained above, according to this invention, it becomes possible to show the roadway form seen from a driver's viewpoint certainly and promptly, without receiving influence in an environmental condition.

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[Translation done.]